Photonic Crystal Laser Technology Based on Nanostructured III-V Active Material

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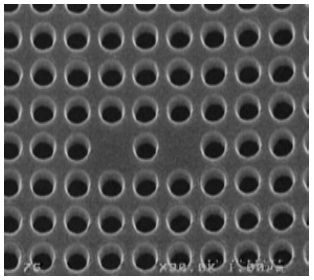
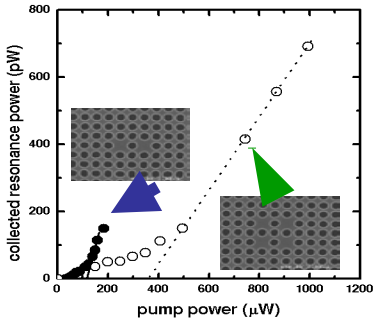
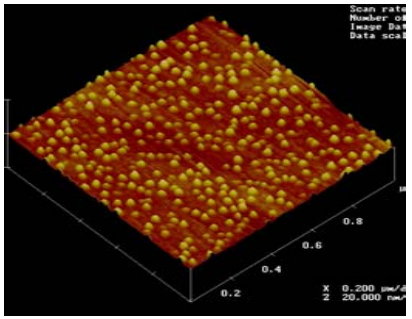
DMR 0103134

This project combines two new types of nanostructured materials, self-organized epitaxial quantum dots and nano-lithographically defined photonic crystals, to generate the first quantum dot photonic crystal lasers. This new materials combination has resulted in the world's first quantum dot photonic crystal laser. The result is a very compact, highly engineerable new type of laser source. Electron. Lett. **38**, 799 (2002).





Scanning electron microscope of two-defect photonic crystal laser cavity (lattice spacing ~0.4 μm) containing InAs QDs, and lasing characteristics.



Atomic force microscope image of InAs quantum dots, with growth interrupted just after dot formation, that act as the active material in the photonic crystal laser above. (QD density $3x10^{10}$ cm^2, QD size ~250 Å diameter, 40 Å tall).

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Education: Six graduate research students have worked on this project, with two, Dr. Oleg Shchekin from UT Austin and Dr. Tomo Yoshie from Cal Tech, obtaining their Ph.D. degrees in Electrical Engineering and Applied Physics. This collaborative project has enabled graduate students from both institutions to participate in new technologies (quantum dots for Cal Tech, photonic crystals for UT) otherwise unavailable.

Award winning research for NSF supported graduate students: As part of this work, Dr. Oleg Shchekin has received two awards for his research into novel quantum dot growth. He was recognized with a Best Student Paper Award from the Electronic Materials Conference in 2002, and the Ben Streetman Prize from UT Austin in 2003 for his new growth process of InAs quantum dots.